Field Phenomics: A web based image analysis platform using open source tools

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***Abstract*—The main goal of any field phenomics platform is to enable plant breeders to detect and evaluate dynamic traits which so far are difficult or inefficient to measure while also requiring destructive sampling. Plant phenotyping is frequently slower and more expensive than genotyping due to the time interval data capture for traits under different environments. Advanced remote sensing technologies such as aerial phenotyping may help expedite the development and selection of climate smart plant varieties. This is an ongoing research project. The main objective of this research is to build an open source web based image analysis platform using opencv (open source computer vision) to analyze field data in the form of images. Computation of vegetative indices to predict plant performance under real field conditions would be a provided outcome.**

***Index Terms*—image processing, remote sensing, opencv,phenomics platform, ndvi, phenotyping, phenotype**

I. Introduction

Application of high-throughput plant phenotyping methods for monitoring plant performance in real field conditions has a high potential to accelerate breeding process. For example in rice, achieving maximum grain yield with fewer input cost is the ultimate goal of intensive rice production. A key step in this process lies in identifying rice varieties that enable farmers to produce higher yield with minimum use of water and fertilizers. Although efforts are taken to achieve this goal, the drawback in traditional phenotypic system makes this process very slow. Also, since this method is destructive, it is impossible to do measurements on the same plant at different time points.

Recent advances in imaging technology tools has enabled more rapid trait/gene discovery, that eventually leads to rapid varietal development adapted to climate change. Advanced remote sensing technologies such as aerial phenotyping help to speed up the development and selection of climate smart plant varieties.

In CIAT(International Center for Tropical Agriculture), phenotyping platform consists of multispectral reflex camera system for image acquisition, some drones and three phenotowers each 8 meters tall mounted with multispectral image system to capture the images from seven different directions, each of the images captured by the sensors for testing, were taken in different phases of plant development and come in two different formats(Multispectral) -see fig1 on page **??**.

An additional perspective of field phenotyping platforms should be to increase precision and real time estimation of parameters in order to identify subtle varietal differences. Even though several Sensors have emerged as integral technologies that can dissect phenotypic components in crop breeding, the issue that now arises is that of data processing and analysis. The need for automated techniques which could evaluate information more rapidly are now a major frontier in field phenomics. The multitudes of generated information from plant trait discovery and the need for validation pipe lines, requires appropriate data management as well as a complex analytical framework for interpretation. However, most of the developed image-analysis tools are constrained in the level of analysis and lack the plasticity to be utilized across species and most are financially unattainable by small scale users.

This paper presents the proposal for implementing a web based image analysis platform using open source technologies freely available, for economically important food crops to start, such as Rice and Cassava, that allow to scientific community and researchers, even to farmers, extract physiological information from the image plants data collected during the crop monitoring process, specifically for calculating VIs(vegetation indices). We calculated 30 VIs (10 different VI formulas three different visible bands) of each plot area, as it is as shown in the table 1, using aerial images collected from various water and nitrogen use efficiency trial sites in *rice* and *cassava* (Manihut esculenta Krantz) a new fully field integrated high throughput image analysis platform is being developed.

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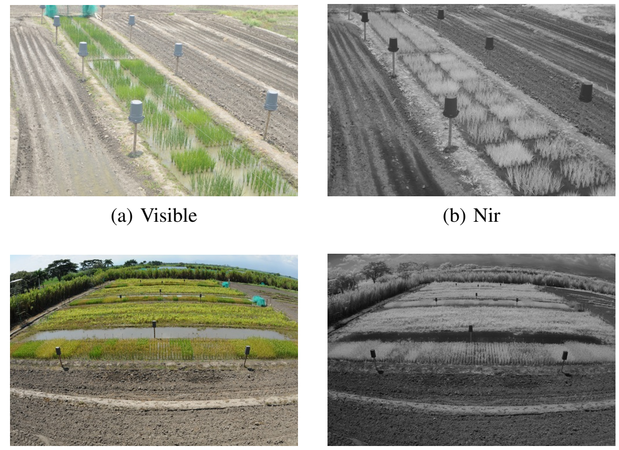
Currently prototypes are being developed and tested for applications that would enhance the plant breeding selection efficiency through rapid image processing in which specific indices are ascertained immediately and instantaneous selections can be made.

TABLE I: Vegetation Indices : Simple ratio (SR), Normalized difference vegetation index(NDVI), Transformed vegetation Index (TVI), Corrected transformed vegetation index (CTVI), Soil-Adjusted vegetation index (SAVI), Difference vegetation index(DVI), Perpendicular vegetation index (PVI), Transformed Soil-Adjusted vegetation index(TSAVI), Modified Soil-Adjusted vegetation index (MSAVI), Weighted Difference Vegetation index(WDVI)

Vegetation Indices
Formula
$SR = \frac{\rho NIR}{\rho VIS}$
$NDVI = \frac{\rho NIR - \rho VIS}{\rho NIR + \rho VIS}$
$TVI = \sqrt{\frac{\rho NIR - \rho VIS}{\rho NIR + \rho VIS}} + 0.5$
$CTVI = \frac{NDVI + 0.5}{ABS(NDVI + 0.5)} * \sqrt{ABS(NDVI + 0.5)}$
$SAVI = \frac{\rho NIR - \rho VIS}{\rho NIR + \rho VIS + L}(1 + L)$
$DVI = \rho NIR - \rho VIS$
$PVI = \frac{(b\rho NIR - \rho VIS) + a}{\sqrt{b^2 + 1}}$
$TSA = a(\rho NIR - a\rho VIS - b)\rho VIS + a\rho NIR - ab + 0.08(1 + a^2)$
$MSAVI = \frac{2\rho NIR + 1 - \sqrt{(2\rho NIR + 1)^2 - 8(\rho NIR - \rho VIS)}}{2}$
$WDVI = \rho NIR - \gamma \rho VIS$



(a) Visible (b) Nir

(c) Visible (d) Nir

Fig. 1: Multispectral rice plants images

II. Conclusions

- Integrated image analysis platform developed from this project will be very useful for all the scientific community and researchers in the development of new varieties of crops.
- Using "images processing techniques" is possible to extract quantitative information of the crops about his growth, development, tolerance, resistance and performance from the images taken in the field, in any phase of plant development, which is a great advantage over the conventional techniques that as mentioned in this research, some often are destructive in the monitoring crop process.

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